PARSONS CREEK WATERSHED
WATER QUALITY REPORT

December 2023

PREPARED FOR

Town of Rye
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Rye, NH 03862

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TRACKING FECAL CONTAMINATION

Current Tools and Challenges

STATEWIDE FECAL CONTAMINATION ISSUE

Surface waters near developed areas are impacted by fecal contamination from polluted stormwater runoff, malfunctioning septic systems, pet, livestock, and wildlife waste, leaky sewer lines, and other aging infrastructure on residential, municipal, and commercial properties. The State of New Hampshire lists over 300 river and estuarine segments as impaired for fecal indicator bacteria (FIB). These impaired waterbodies are particularly concentrated in the populated Seacoast Region. This fecal contamination generates a significant threat to water quality, public health, and the local economy.

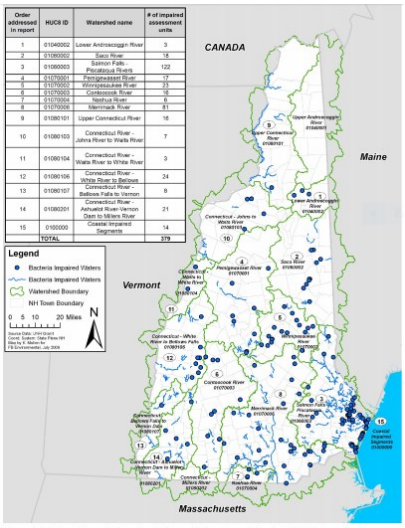
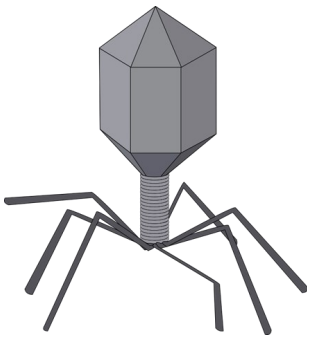


Figure 1-1: Map of Bacteria Impaired Waters in New Hampshire, by HUC 8 Watershed.

TRACKING FECAL SOURCES IS DIFFICULT

Monitoring, tracking, and managing pathogens in fecal matter is extremely difficult, particularly when fecal indicators (e.g., *E.coli,* Enterococci, or fecal coliform) are also highly variable to track and measure. Bacteria and viral pathogens react differently in the natural environment, so that external factors (temperature, sunlight, proliferation, etc.) may influence the concentration of FIB, but not the viral pathogens of interest for protecting public health. In addition, laboratory analysis of FIB can be highly variable due to the biological nature of the bacteria. For instance, laboratory and field duplicates can vary up to 200% or more, particularly at lower concentrations. As such, bacteria results should not be interpreted as absolute numbers, but as a rough estimate of concentration.



To aid with fecal source tracking, other parameters can be used as “co-indicators” to help determine if the source of the bacteria is from human waste. Nutrients (ammonia) and optical brighteners can indicate the presence of human sewage in high concentrations (0.9 ppm for ammonia and positive results for optical brighteners). Optical brighteners are brightening or whitening agents used in laundry detergents and are often present in wastewater. If surface waters present elevated FIB counts and high nutrient levels or positive results for optical brighteners then it is likely that the fecal contamination is from illicit discharges of human waste rather than other sources like stormwater runoff or animal waste.

Designed by L. Diemer, FBE
Graphic credit: OpenClipArt

BEACH MONITORING

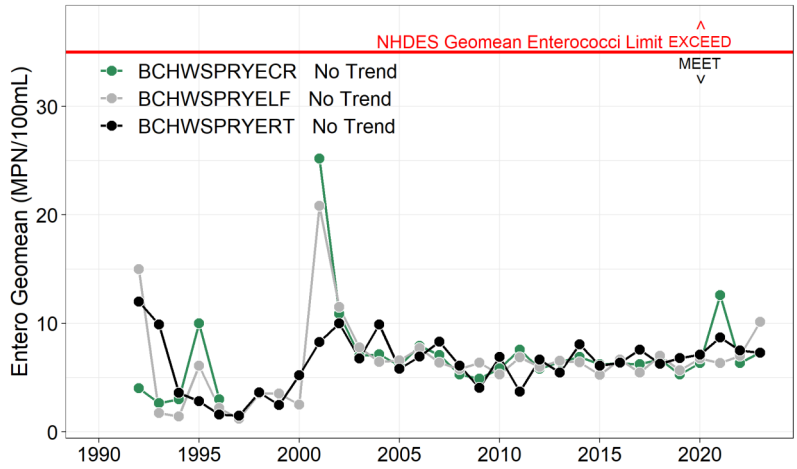
Wallis Sands State Beach and Wallis Beach, Rye, NH

NHDES BEACHES PROGRAM

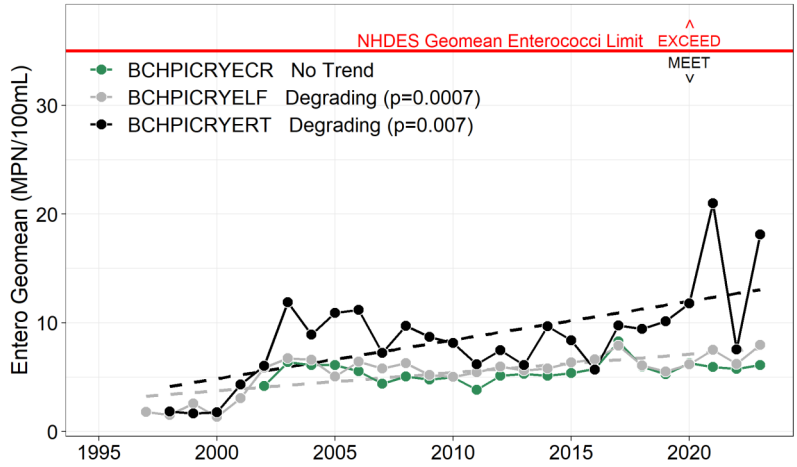
NHDES conducts regular sampling of freshwater and coastal beaches and issues advisories if FIB counts exceed water quality criteria established for the protection of public health. The annual geometric means for the six monitored beach sites were well within acceptable limits for NHDES water quality criteria, but two sites (BCHPICRYELF and BCHPICRYERT) on Wallis Beach showed statistically-significant degrading trends from 1997-2023 and 1998-2023, respectively. Wallis Sands State Beach was issued no advisories in 2023, one advisory in 2022, two advisories in 2021, and one advisory in 2017; Wallis Beach was issued two advisories in 2023, one advisory in 2022, three advisories in 2021, and one advisory in each of the following years: 2020, 2018, 2017, 2014, 2010, 2009, 2008, and 2006. In 2023, FIB counts at Wallis Sands State Beach did not exceed 104 mpn/100mL at any site. At Wallis Beach, FIB counts were elevated four times at BCHPICRYERT (7/5/23, 7/7/23, 7/10/23, and 8/3/23) with levels ranging between 145-243 mpn/100mL.

Wallis Beach has shown elevated and worsening FIB counts at BCHPICRYERT, the swimmable area near the outlet of Parsons Creek.

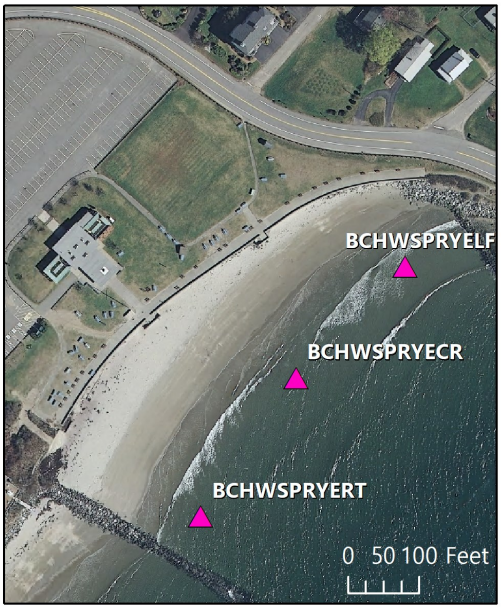
Wallis Sands State Beach Monitoring Sites



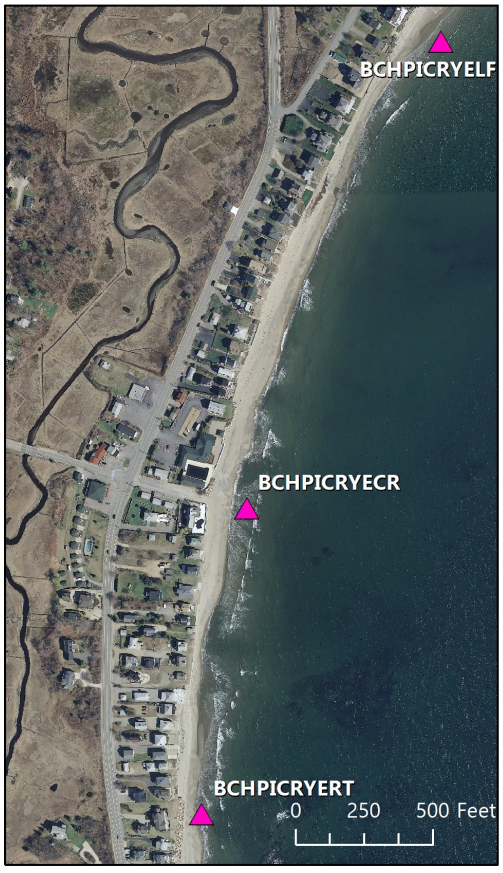
Wallis Beach Monitoring Sites



Wallis Sands State Beach



Wallis Beach



WATERSHED

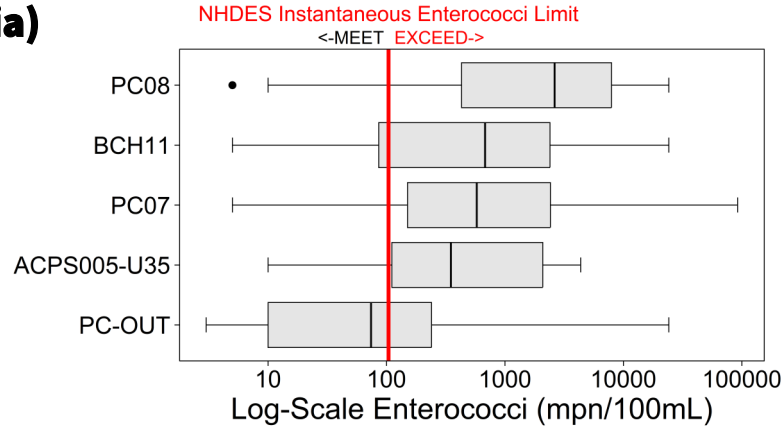
Parsons Creek, Rye, NH

WATERSHED MONITORING (Bacteria)

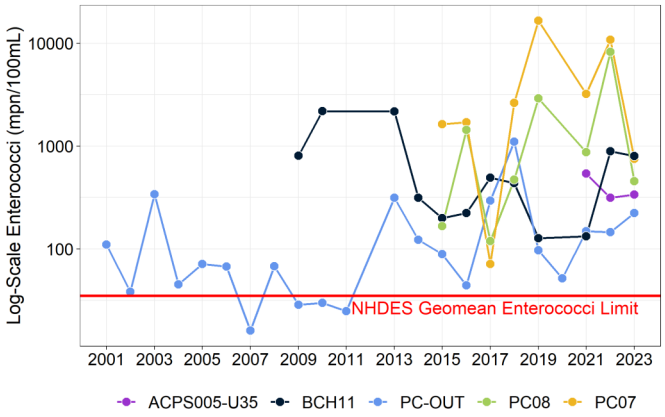
Five sites (ACPS005-U35, PC07, PC08, BCH11, and PC-OUT) within the Parsons Creek watershed were sampled for Enterococci six times at low tide during wet and dry weather conditions from June through September in 2023, with PC-OUT sampled one additional time on 7/19/23. These sites have showed historically-elevated levels of Enterococci for multiple years and have been positive for human fecal contamination by either ribotyping or canine detection or both.

All sites exceeded the state criterion for geometric mean (35 mpn/100mL) in 2023. All but 7 out of 33 samples (PC07 and BCH11 on 6/1/23, ACPS005-U35 on 6/1/23 and 6/14/23, and PC-OUT on 6/1/23, 6/14/23, and 8/3/23) surpassed the instantaneous state criterion (104 mpn/100mL) in 2023. Duplicate samples were omitted from the data distributions and geometric means for Enterococci. Refer to Appendix A-B for data and Appendix C for methods.

Similar to previous years, FIB counts exceeded state criteria at all five locations in Parsons Creek (ACPS005-U35, PC07, PC08, BCH11, and PC-OUT). FIB counts at PC08, PC07, and BCH11 remain high but were lower than previous years. FIB counts at PC-OUT may be worsening since around 2011.



All data (2001-2023) distribution for the five sites monitored in 2023. Sites ordered from highest to lowest median value.



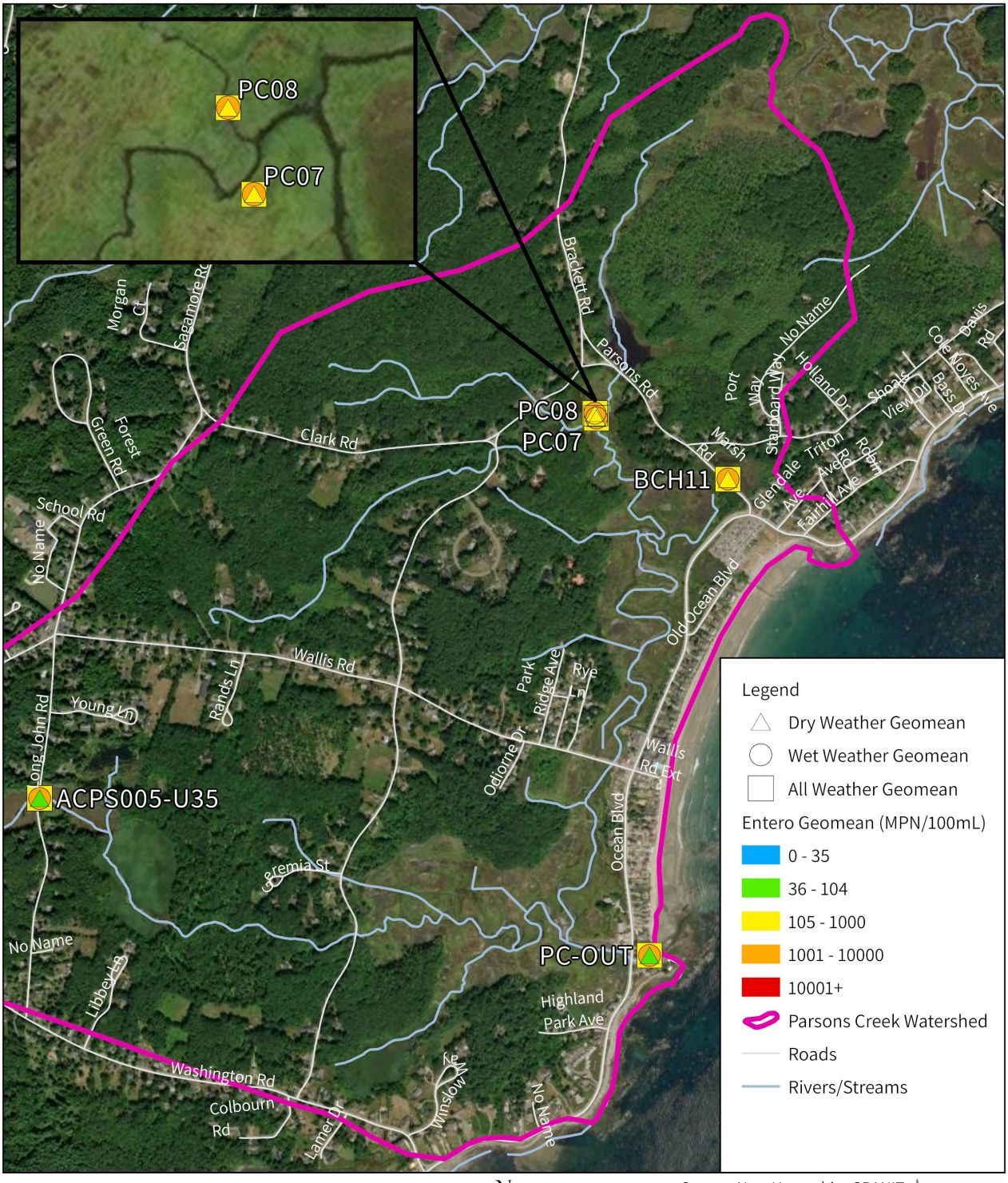
Annual geometric mean from 2001-2023 for the five sites monitored in 2023.

View of site BCH11 on June 27 , 2023 Photo Credit: FBE.

View of site ACPS005-U35 on June 14, 2023 Photo Credit: FBE.

WATERSHED MONITORING

Parsons Creek, Rye, NH



2023 Bacteria Results Parsons Creek, Rye, NH

N

0 0.25 0.5 1 Miles

Source: New Hampshire GRANIT, FB Environmental, ESRI, Watershed Area from NHDES
Projection: NAD 1983 New Hampshire State Plane FIPS 2800ft
Created by: FB Environmental, E. Ma, October 2023

WET/DRY WEATHER ANALYSIS

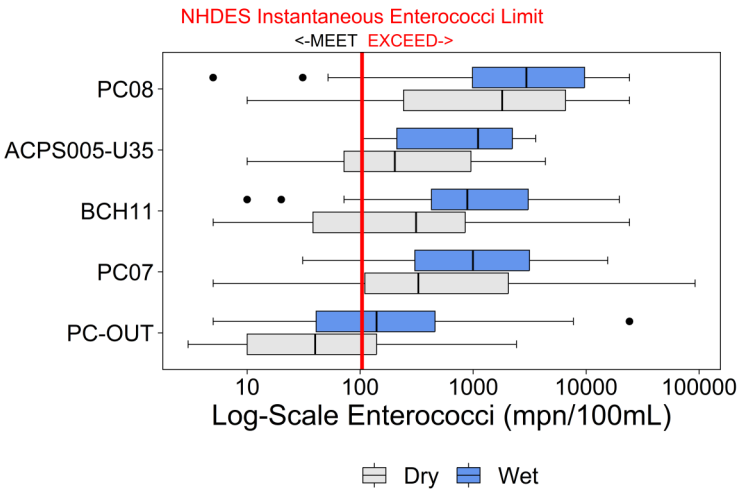
Parsons Creek, Rye, NH

WET/DRY WEATHER ANALYSIS (Bacteria)

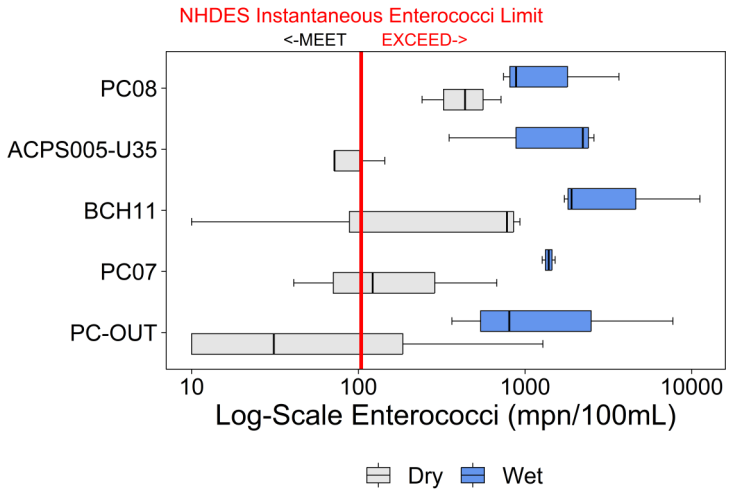
Wet weather in 2023 generated far higher counts of FIB in surface waters compared to dry weather for all sampling locations, suggesting that land-based runoff may be a significant source of fecal contamination in the Parsons Creek watershed. FIB was still elevated during dry weather conditions, particularly at PC08 and BCH11, demonstrating that groundwater is also a source of fecal bacteria to Parsons Creek. All sites exceeded the state criterion for the geometric mean of FIB (35 mpn/100mL) during both dry and wet weather.

Historically and in 2023, FIB counts exceeded state criteria during both wet and dry weather, suggesting that both stormwater runoff and groundwater are significant sources of contamination to Parsons Creek. The low-lying topography and high groundwater table in the watershed make leachfields susceptible to malfunction, which is likely the primary source of fecal contamination in the watershed and at the beaches.

PC08 during wet weather on August 31, 2023 (top) and BCH11 during dry weather on June 14, 2023 (bottom).
Photo Credit: FBE.



All data (2001-2023) distribution for the five sites monitored in 2023 by weather condition (dry and wet).



2023 data distribution for the five sites monitored in 2023 by weather condition (dry and wet).

WATERSHED MONITORING

Parsons Creek, Rye, NH

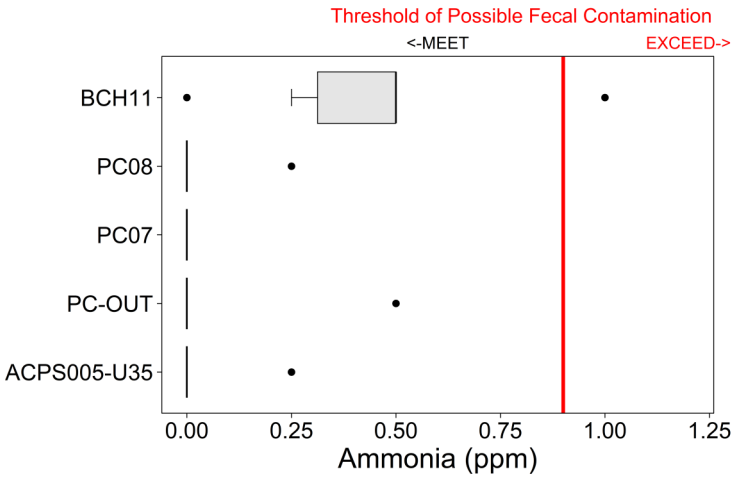
WATERSHED MONITORING (Co-Indicators)

Five sites (ACPS005-U35, PC07, PC08, BCH11, and PC-OUT) within the Parsons Creek watershed were tested for ammonia (using Hach test strips) six times and sampled for optical brighteners twice at low tide during wet and dry weather conditions from June through September in 2023. Concentrations of ammonia greater than 0.9 ppm (Tillet et al., 2018) or positive results for optical brighteners would suggest that the dominant source of fecal contamination is from illicit discharges of human waste.

There were no sites that had an average ammonia concentration that exceeded the threshold of possible fecal contamination (>0.9 ppm); however, one site (BCH11) had one sample that exceeded the threshold. On three other occasions, BCH11 had ammonia concentrations that approached but did not exceed the threshold, reaching 0.5 ppm. PC-OUT was observed to have an ammonia test-strip reading of 0.5 ppm on 6/1/2023, though this result was coupled with low (below detection) FIB counts. Elevated ammonia concentrations could be an indicator fecal contamination; however, it could also be the result of naturally occurring chemical reactions in the salt marsh environment. For optical brighteners, samples were negative across all sites and sampling dates, indicating either that household waste was not present in the sample or that optical brighteners are not the most effective co-indicator of fecal contamination for the Parsons Creek watershed. Duplicate samples were not included in the data distributions and averages. Refer to Appendices A-B for data and Appendix C for methods.

Average ammonia concentrations were below the thresholds of possible fecal contamination for all sites. Although the averages were not exceeded, one individual sample at BCH11 exceeded the threshold for ammonia, suggesting that there may be fecal contamination in that area. Other ammonia samples at BCH11 and one at PC-OUT did not exceed the threshold, but did show values approaching 0.9 ppm. Optical brightener samples were negative for all sites across all sampling dates.

View of site PC07on June 27, 2023 (top) and view of site PC-OUT on September 11, 2023 (bottom). Photo Credit: FBE.

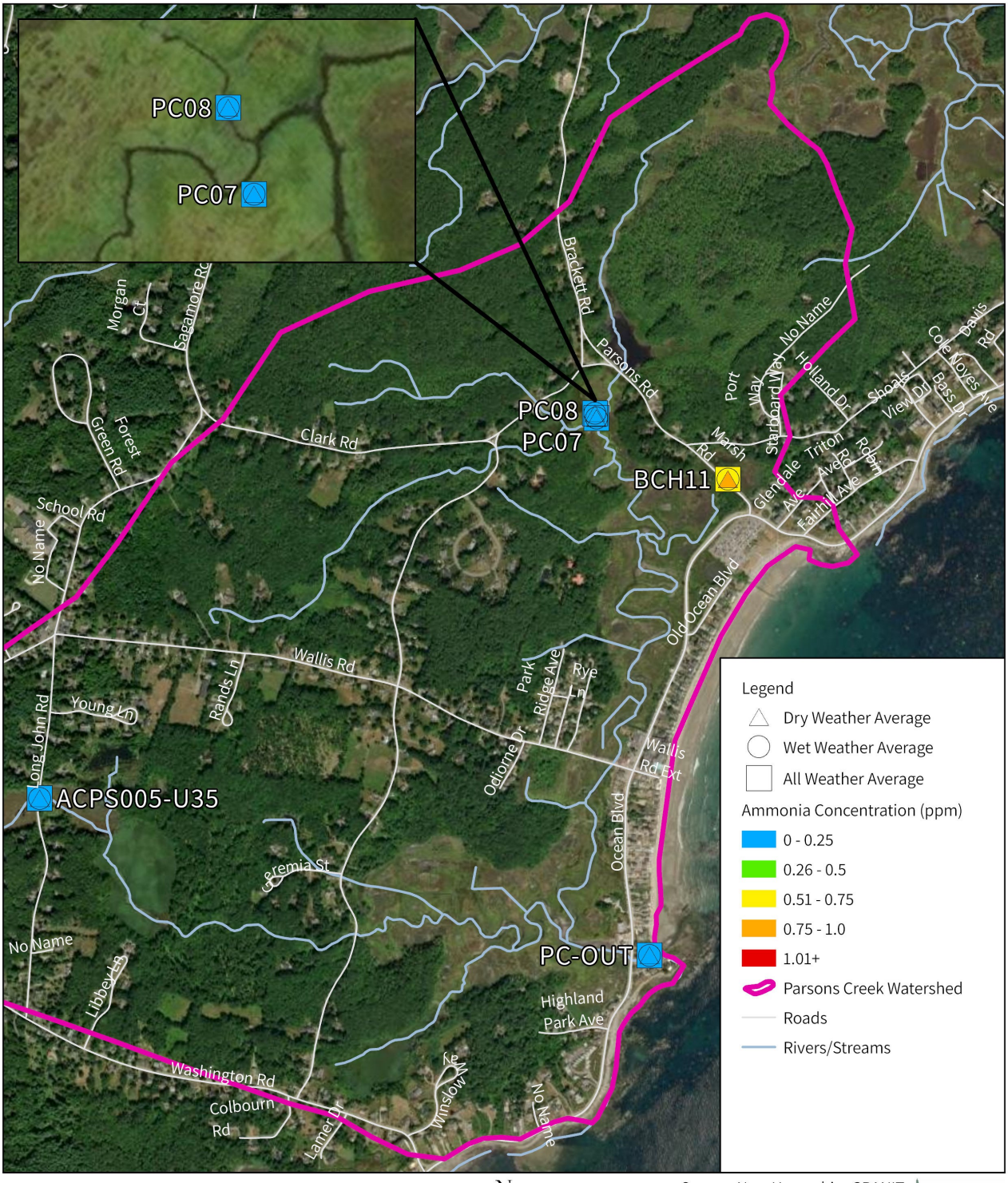


2023 data distribution for ammonia. Sites ordered from highest to lowest median value.

View of site BCH11 on June 1, 2023. Photo Credit: FBE

WATERSHED MONITORING

Parsons Creek, Rye, NH



2023 Ammonia Results Parsons Creek, Rye, NH

N

0 0.25 0.5 1 Miles

Source: New Hampshire GRANIT, FB Environmental, ESRI, Watershed Area from NHDES
Projection: NAD 1983 New Hampshire State Plane FIPS 2800ft
Created by: FB Environmental, E. Ma, October 2023

SUMMARY

Snapshot of Results

Overall, the Town of Rye, the NHDES Beaches Program, the NHDES Watershed Assistance Section, the NH Shellfish Program, FB Environmental Associates, the Jackson Laboratory, and Environmental Canine Services have done a considerable amount of work to track sources of fecal contamination in both surface water and groundwater within the Parsons Creek watershed and along the beach. This work has generated a long-term dataset for analysis and interpretation for determining next steps in dealing with this issue. A summary of results is provided below.

Beach Monitoring Results

- ⇒ Wallis Sands State Beach was not issues an advisory in 2023, which is less than previous years, while Wallis Beach was issued two advisories in 2023, an increase compared to 2022.
- ⇒ Two sites on Wallis Beach (BCHPICRYELF and BCHPICRYERT) showed statistically-significant degrading trends over time; BCHPICRYERT showed high FIB counts in 2023 that exceeded the threshold of 104 mpn/100mL on four occasions (7/5/23, 7/7/23, 7/10/23, and 8/3/23) with levels ranging between 145-243 mpn/100mL.
- ⇒ Historical results have shown the critical connection between Parsons Creek water quality and protection of public health at the beach.

Watershed Monitoring Results

- ⇒ In 2023, all sites sampled within the Parsons Creek watershed had FIB counts that exceeded the state criterion for the geometric mean. Historical investigations by human waste tracking canines showed that human fecal contamination is a diffuse problem throughout the watershed due to the area's low-lying topography and high groundwater table that likely intercepts leachfields on a regular basis during storm events and/or spring tides. Even if a high water table is not the issue, sandy soils would allow for fast percolation rates of contaminated leachfield water to groundwater and ultimately surface waters without adequate treatment of pathogens.
- ⇒ Average ammonia concentrations in 2023 were below the general guideline for possible fecal contamination at all sites; however, one site in the upper watershed (BCH11) exceeded the criteria for ammonia on one individual sample date. Illicit discharge of human waste is possibly a source of fecal contamination at this site; however, it could also be the result of naturally occurring chemical reactions in the salt marsh environment. Samples for optical brighteners, another co-indicator of fecal contamination, were negative across all sites and all sampling dates.

Wet/Dry Weather Analysis

- ⇒ Historically and in 2023, FIB counts exceeded state criteria during both wet and dry weather, suggesting that both stormwater runoff and groundwater are significant sources of fecal contamination to Parsons Creek and the beach.
- ⇒ Results from 2023 showed that FIB counts were generally higher during wet weather sampling events, suggesting that land-based runoff was a larger source of fecal contamination to Parsons Creek this year due to wetter conditions. Failing septic systems can be a considerable source of fecal contamination through surface runoff, especially during storm events. Other sources of fecal contamination during wet weather include stormwater runoff and wildlife.

NEXT STEPS

Recommendations and Priorities

Address groundwater sources of fecal contamination

- ⇒ Update the septic system database on a regular basis.
- ⇒ Continue to enforce the septic system health regulation that requires pump-outs every 3 years.
- ⇒ Continue evaluation of individual properties for septic system functioning near hotspots.
- ⇒ Consider implementing a mandatory septic system inspection program for properties in the Parsons Creek watershed.
- ⇒ Consider incorporating stricter guidelines for septic system replacement or installation to town ordinances.

Address surface runoff sources of fecal contamination

- ⇒ Consider performing a watershed survey to locate candidate sites for BMP implementation to address stormwater runoff.
- ⇒ Continue to secure funding that implements these candidate BMP sites.
- ⇒ Establish a program within the Town to monitor and maintain BMP sites.
- ⇒ Maintain installed pet waste signs and consider installing additional pet waste disposal stations in high-trafficked areas.

Enhance public outreach program

- ⇒ Install permanent signs at beach access points near the outlet of Parsons Creek to discourage the public from swimming in that area due to historically high levels of bacteria.
- ⇒ Continue to distribute educational materials and reports to the public via the Town's website.
- ⇒ Consider hosting workshops to educate homeowners on proper maintenance of septic systems.
- ⇒ Reinstitute regular meetings of the Parsons Creek Water Quality Committee.

Continue monitoring program

- ⇒ Continue water quality sampling throughout the Parsons Creek watershed under varying weather conditions to track changes in FIB over time, especially as failing septic systems are replaced.
- ⇒ Add mitochondrial DNA analyses to the annual monitoring program to aid in identifying potential sources of fecal contamination.
- ⇒ Consider updating the 2011 Parsons Creek Watershed Based Plan.
- ⇒ Conduct a groundwater modeling study to identify potential pathways of fecal contamination from septic systems to the Creek and locate specific septic systems at risk of malfunctioning due to high water levels.

APPENDIX A

2023 Watershed Monitoring Data

Date	Dry/Wet	Site ID	Water Temp (°C)	DO (ppm)	Specific Conductivity (µS/cm)	Salinity (ppt)	pH	Enterococci (mpn/100mL)	Ammonia (ppm)	Optical Brighteners
06/01/23	Dry	PC-OUT	21.6	6.24	38,966	24.90	7.47	<10	0.50	—
06/01/23	Dry	BCH11	17.7	*0.21*	21,925	13.21	6.69	10	0.50	—
06/01/23	Dry	PC08	27.9	*2.57*	7,707	4.24	6.81	*717*	0.00	—
06/01/23	Dry	PC07	25.6	18.18	4,395	2.34	7.92	41	0.00	—
06/01/23	Dry	ACPS005-U35	17.0	*0.78*	347	0.17	6.93	72	0.00	—
06/14/23	Dry	PC-OUT	22.3	6.38	37,939	24.11	7.26	10	0.00	—
06/14/23	Dry	BCH11	20.5	*1.51*	32,731	20.51	6.77	*932*	*1.00*	—
06/14/23	Dry	PC08	23.9	*1.03*	25,917	15.83	6.75	*241*	0.00	—
06/14/23	Dry	PC07	20.6	12.06	13,868	8.05	7.14	*122*	0.00	—
06/14/23	Dry	ACPS005-U35	16.9	*0.19*	370	0.18	7.35	72	0.00	—
06/27/23	Wet	PC-OUT	20.8	6.02	9,065	5.09	7.05	*7,701*	0.00	—
06/27/23	Wet	BCH11	19.8	*0.35*	24,297	14.80	6.53	*1,904*	0.50	—
06/27/23	Wet	PC08	21.5	*4.32*	2,278	1.17	7.07	*743*	0.00	—
06/27/23	Wet	PC07	18.2	7.36	1,080	0.54	7.03	*1,515*	0.00	—
06/27/23	Wet	ACPS005-U35	18.2	*0.31*	302	0.14	6.92	*2,224*	0.00	—
07/19/23	Dry	PC-OUT	20.1	*3.35*	28,697	17.75	6.81	*1,281*	0.00	—
08/03/23	Dry	PC-OUT	17.0	*4.14*	45,921	29.83	7.05	97	0.00	Negative
08/03/23	Dry	BCH11	17.3	*0.57*	39,043	24.92	6.92	*780*	0.25	Negative
08/03/23	Dry	PC08	17.7	*2.44*	39,938	25.55	6.96	*437*	0.00	Negative
08/03/23	Dry	PC07	17.7	*1.47*	41,050	26.50	6.48	*677*	0.00	Negative
08/03/23	Dry	ACPS005-U35	18.4	*0.53*	380	0.18	7.07	*144*	0.25	Negative
08/31/23	Wet	PC-OUT	17.5	*3.78*	39,255	25.07	6.80	*805*	0.00	Negative
08/31/23	Wet	BCH11	18.2	*0.89*	13,530	12.70	6.58	*1,720*	0.00	Negative
08/31/23	Wet	PC08	18.1	*0.59*	22,760	13.79	6.67	*884*	0.25	Negative
08/31/23	Wet	PC07	18.8	*0.45*	28,068	17.37	6.79	*1,266*	0.00	Negative
08/31/23	Wet	ACPS005-U35	17.7	*0.46*	256	0.12	6.67	*350*	0.00	Negative
09/11/22	Wet	PC-OUT	22.6	6.45	30,401	18.89	6.90	*364*	0.00	—
09/11/22	Wet	BCH11	22.1	*0.34*	23,965	14.55	7.22	*11,199*	0.50	—
09/11/22	Wet	PC08	24.6	*0.56*	10,418	5.88	7.09	*3,654*	0.00	—
09/11/22	Wet	PC07	20.7	6.95	2,955	1.54	7.60	*1,388*	0.00	—
09/11/22	Wet	ACPS005-U35	20.2	*0.56*	356	0.17	7.44	*2,589*	0.00	—

Italicized red text indicates exceedance of the state criterion threshold or natural background guideline for individual samples (DO = 5 ppm; Enterococci = 104 mpn/100mL; Ammonia = 0.9 ppm).

APPENDIX B

2023 Watershed Monitoring Data QA/QC

Date	Dry/Wet	Site ID	Rep	Enterococci (mpn/100mL)	Enterococci RPD
08/03/2023	Dry	PC08	1	437	39%‡
08/03/2023	Dry	PC08	2	650	
08/31/2023	Wet	BCH11	1	1720	4%
08/31/2023	Wet	BCH11	2	1658	

‡RSD < 30%, therefore the elevated RPD is acceptable

No enterococci samples were flagged for elevated field duplicates. Values are flagged if the Relative Percent Difference (RPD) is greater than 20%, the Relative Standard Deviation (RSD) is greater than 30%, and the values are greater than five times the detection limit. Since the RPD is only greater than 20% for one sampling event, and the RSD for the duplicate sample during that one sampling event is less than 30%, these data are acceptable. Only two field duplicates were taken in 2023.

APPENDIX C

Summary of Methods

SAMPLING PROTOCOL

Baseline bacteria sampling was performed as documented in the *NHDES Generic Beach Program Quality Assurance Project Plan* dated April 3, 2012, RFA # 06193, Section B2.0. Bacteria samples were collected in labeled whirlpak bags and stored on ice in a cooler for transport to Absolute Resource Associates Laboratory in Portsmouth, NH for analysis of Enterococci. Water was tested in the field for ammonia using Hach AquaChek Water Quality Test Strips for Ammonia. Water quality parameters (temperature, dissolved oxygen, specific conductivity, salinity, and pH) were collected in the field using calibrated instruments: YSI ProSolo and Oakton pHTestr® 30. Samples for optical brighteners were collected in foil-wrapped Falcon tubes and analyzed using an Aquafluor® handheld fluorometer in accordance with Burres (2011). Two duplicate samples were collected and generally fell within the acceptable difference (see Appendix B).

WET/DRY WEATHER CLASSIFICATION

Wet weather was determined as: >0.1" of precipitation in the prior 24 hours; or >0.25" in the prior 48 hours; or >2.0" in the prior 96 hours. Conditions were considered dry weather when precipitation was <0.1" for each day within 72 hours.

STATISTICAL METHODS

A Mann-Kendall trend analysis was performed for beach sites with at least 10 years of data. The Mann-Kendall Trend Test is a non-parametric statistical test that determines if the central value (median) of a dataset has changed over time. A non-parametric test is appropriate here because it does not make assumptions about the normality or variability of the dataset; variation seen year-to-year or within seasons will not influence the results of non-parametric analysis the way that parametric tests can be influenced.

DATA INTERPRETATION – WATER QUALITY STANDARDS

The NHDES Consolidated Assessment Listing Methodology (CALM) describes the process and water quality standards used to assess the state's waters. This information is used to help interpret Parsons Creek water quality results and relate it to state criteria. https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/r-wd-20-20.pdf

REFERENCES

Burres, E. (2011). Measuring Optic Brighteners in Ambient Water Samples Using a Fluorometer. Standard Operating Procedure (SOP) 3.4.1.4. Updated March 2011.

Tillett, B.J., Sharley, D., Almeida, M.I.G.S., Valunzuela, I., Hoffmann, A.A., & Pettigrove, V. (2018). A short work-flow to effectively source faecal pollution in recreational waters—A case study. Science of the Total Environment, 644, 1503-1510. https://doi.org/10.1016/j.scitotenv.2018.07.005